



# *U.S. GPS Policy and Constellation Status*

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5<sup>th</sup> International Satellite Navigation  
Forum

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# *Overview*

- U.S. National Space Policy
- International Cooperation Activities
- GPS Constellation Status Update
- U.S. Wide Area Augmentation System  
(WAAS)



# *Need for A New U.S. Space Policy*

- Since 2006, various domestic and international developments have changed the opportunities, challenges, and threats facing the U.S., including its space capabilities
- **New opportunities for international cooperation; evolving/maturing commercial capabilities and options**
  - **More space actors, increased debris, need for enhanced transparency and stability**
- The U.S. National Space Policy accounts for those changes and reflects the integral role space plays in U.S. economic, national, and homeland security
- Continuity of fundamental policy precepts
- Every President since President Eisenhower has issued a space policy



# *U.S. National Space Policy*

## *Space-Based PNT Guideline: Maintain leadership in the service, provision, and use of GNSS*

- Provide civil GPS services, free of direct user charges
  - Available on a continuous, worldwide basis
  - Maintain constellation consistent with published performance standards and interface specifications
  - Non-U.S. PNT services may be used to complement services from GPS
- Encourage global compatibility and interoperability with GPS
- Promote transparency in civil service provision
- Enable market access to industry
- Support international activities to detect and mitigate harmful interference



# *Planned GNSS*

- Global Constellations
  - **GPS (24+)**
  - GLONASS (30)
  - Galileo (27+3)
  - Compass (27+3 IGSO + 5 GEO)
- Regional Constellations
  - QZSS (3)
  - IRNSS (7)
- Satellite-Based Augmentations
  - **WAAS (3)**
  - MSAS (2)
  - EGNOS (3)
  - GAGAN (2)
  - SDCM (2)



# *U.S. Objectives in Working with Other GNSS Service Providers*

- Ensure **compatibility** – ability of U.S. and non-U.S. space-based PNT services to be used separately or together without interfering with each individual service or signal
  - Radio frequency compatibility
  - Spectral separation between M-code and other signals
- Achieve **interoperability** – ability of civil U.S. and non-U.S. space-based PNT services to be used together to provide the user better capabilities than would be achieved by relying solely on one service or signal
  - Primary focus on the common L1C and L5 signals
- Promote fair competition in the global marketplace

***Pursue through Bilateral and Multilateral Cooperation***



# *Bilateral Cooperation*

- **U.S.-Russia** Joint Statement issued December 2004
  - Working Groups: compatibility/interoperability, search/rescue
- **U.S.-China** operator-to-operator coordination under ITU auspices is complete
  - Bilateral Meetings in 2007, 2008, 2009, 2010
- **U.S.-India** Joint Statement on GNSS Cooperation 2007
  - Technical Meetings focused on GPS-India Regional Navigation Satellite System (IRNSS) compatibility and interoperability held in 2008 and 2009
  - Continuation of ITU compatibility coordination is pending



# *Bilateral Cooperation (continued)*

- **U.S.-EU** GPS-Galileo Cooperation Agreement signed in June 2004
  - Four working groups set up under the Agreement
- **U.S.-Japan** Joint Statement on GPS Cooperation 1998
  - Quasi Zenith Satellite System (QZSS) designed to be fully compatible and highly interoperable with GPS
  - Bilateral agreements set up QZSS monitoring stations in Hawaii and Guam
- **U.S.-Australia** Joint Delegation Statement on Cooperation in the Civil Use of GPS in 2007
  - Bilateral meeting in Washington, D.C., Oct. 26-27, 2010
  - GNSS and applications included in expanded space cooperation, as discussed in October 27, 2010 Joint Announcement



# *International Committee on Global Navigation Satellite Systems (ICG)*

- Emerged from 3rd UN Conference on the Exploration and Peaceful Uses of Outer Space July 1999
  - Promote the **use of GNSS** and its **integration into infrastructures**, particularly in developing countries
  - Encourage **compatibility and interoperability** among global and regional systems
  - Met annually since 2006
- Members include:
  - **GNSS Providers** — China, EU, India, Japan, Russia, United States
  - Other interested Member States of the United Nations
  - International organizations/associations



# *ICG Providers Forum*

- Six space segment providers listed previously are members
- Purpose:
  - Focused discussions on **compatibility and interoperability**, encouraging development of complimentary systems
  - Exchange detailed information on systems & service provision plans
  - Exchange views on ICG work plan and activities
- Providers have agreed that all GNSS signals and services must be compatible and open signals and services should also be interoperable to the maximum extent possible
  - Working definition of **compatibility** includes respect for spectral separation between each system's authorized service signals and other systems' signals
  - **Interoperability** definition addresses signal, geodetic reference frame realization, and system time steerage considerations



# GPS Constellation

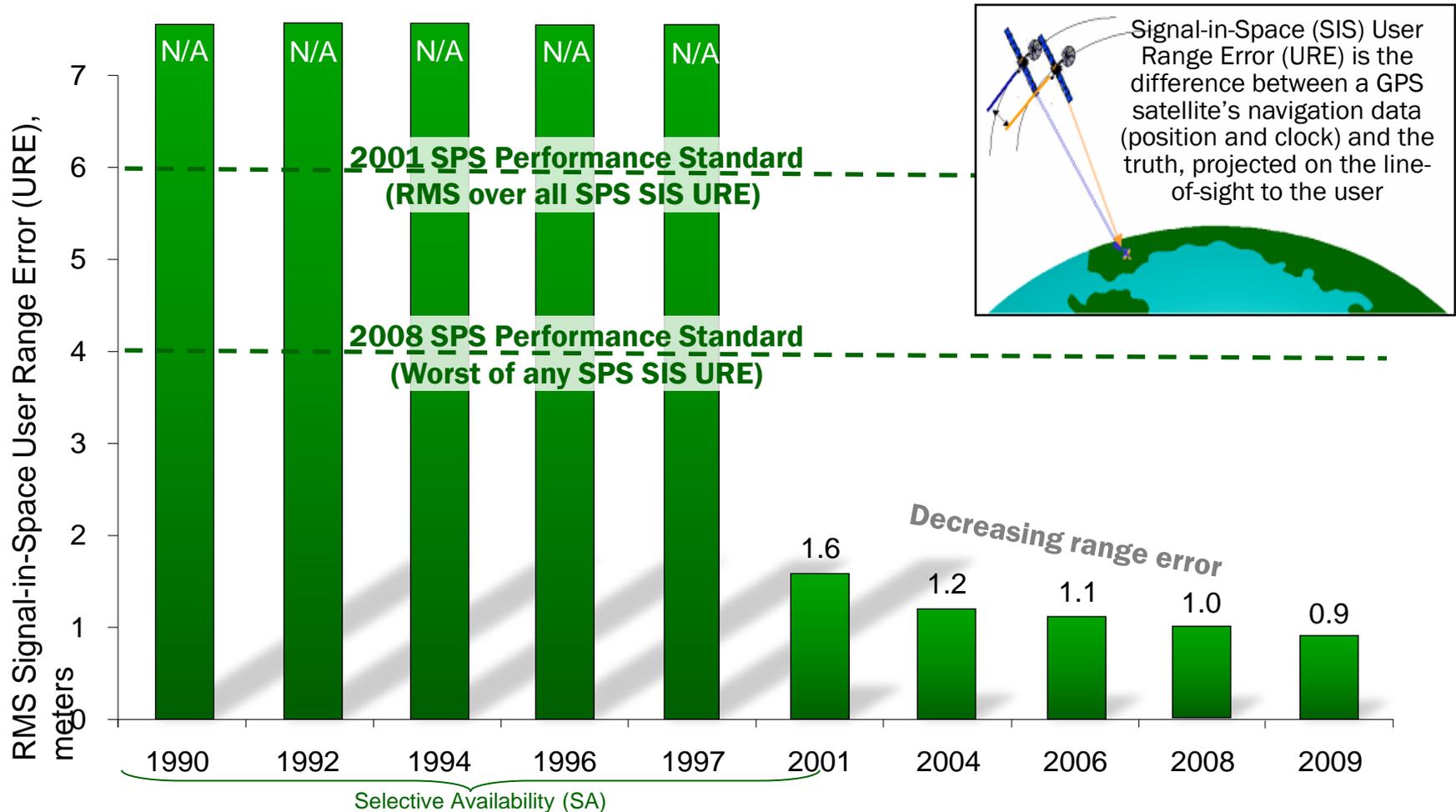
- 31 space vehicles currently operational
  - 11 GPS IIA
  - 12 GPS IIR
  - 7 GPS IIR-M
  - 1 GPS IIF
- 3 additional satellites in residual status
- IIF SV-2 scheduled to launch by 14 July 2011
- IIIA SV-1 scheduled launch 2014
- Continuously assessing constellation health to determine launch need



***Global GPS service performance commitment met continuously since December 1993***



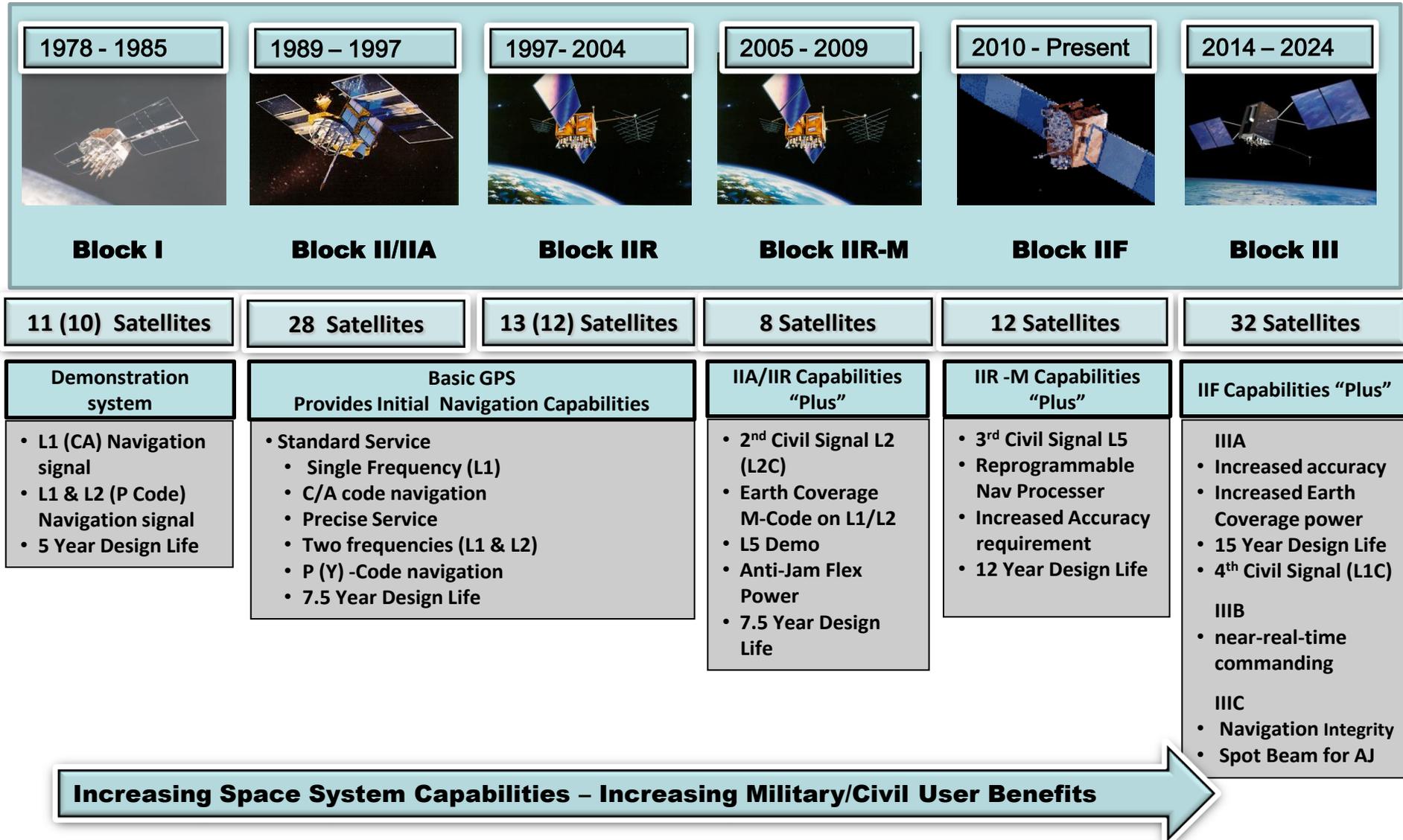
# GPS SPS Signal in Space Performance



*System accuracy exceeds published standard*



# GPS Modernization Program





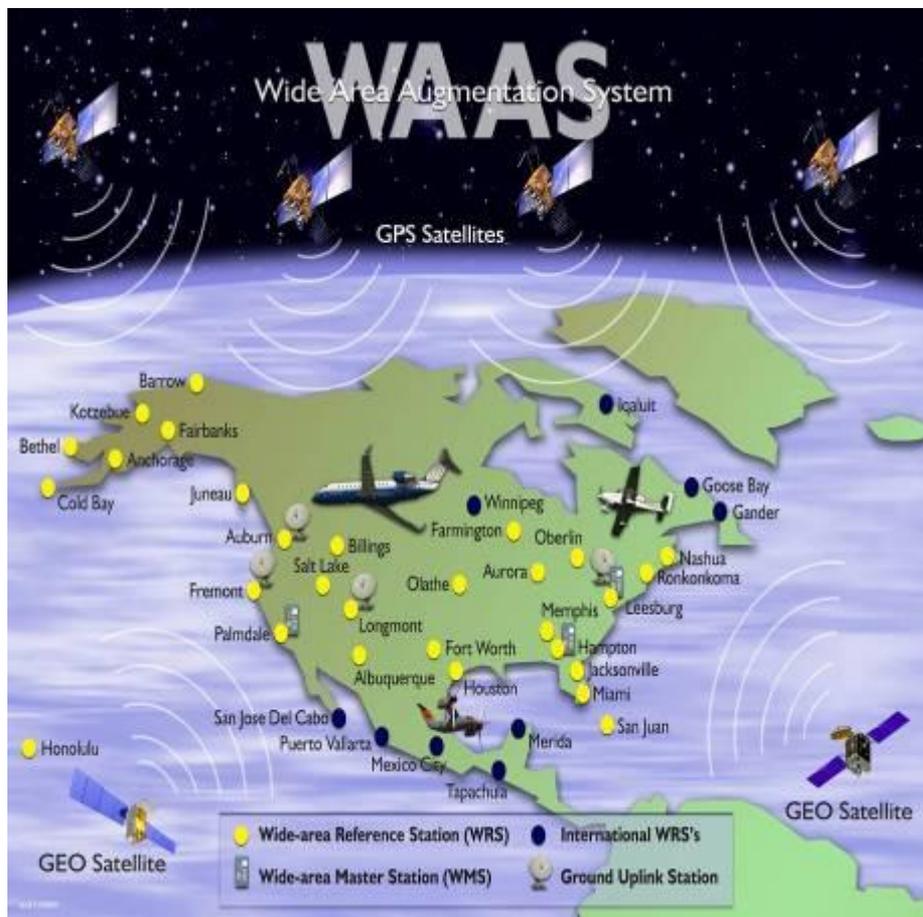
# *Advanced Control Segment (OCX)*

- Architecture Evolution Plan (AEP)
  - Transitioned in 2007
  - Increased worldwide commanding capability
  - Increased capacity for monitoring of GPS signals
  - Modern distributed system replaced 1970s mainframes
- Next Generation Advanced Control Segment (OCX)
  - Controls more capable constellation, and monitors all GPS signals
  - \$1.5B contract awarded 25 February 2010
  - Capability delivered incrementally to reduce risk
  - Preliminary Design Review scheduled for June 2011
  - Full Capability by ~2016



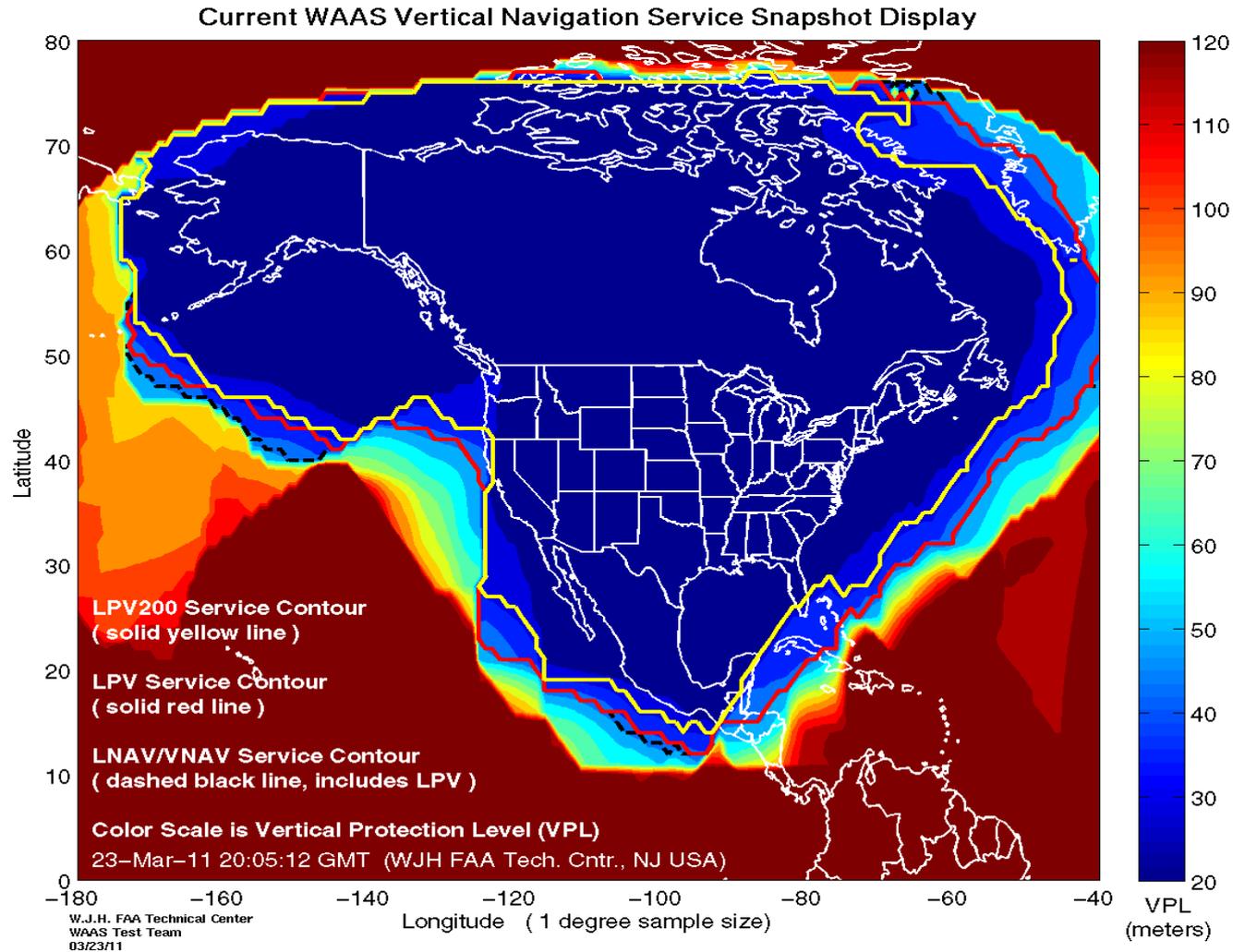


# Wide Area Augmentation System (WAAS) Architecture



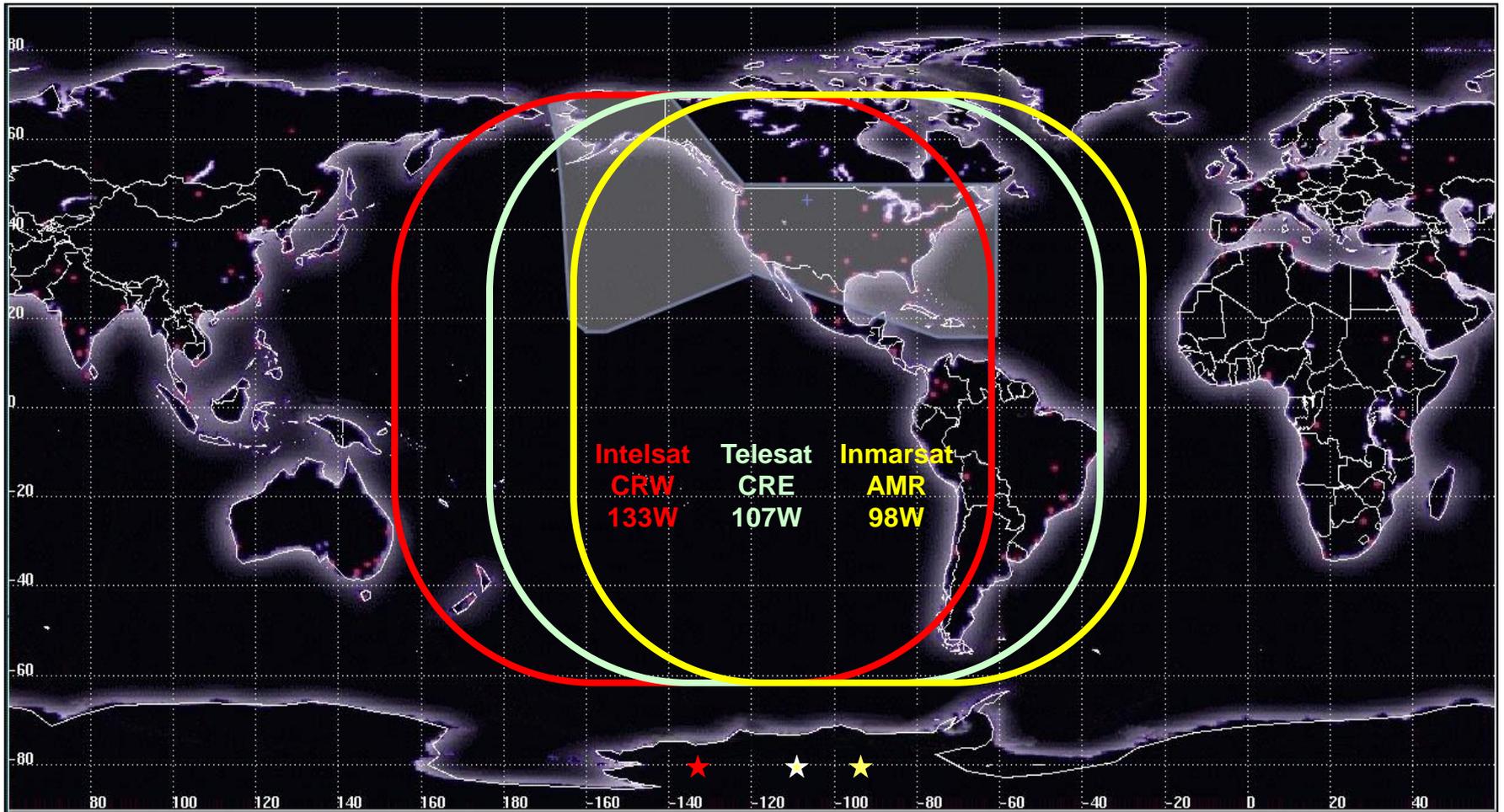


# Current WAAS Availability





# Current WAAS Geo Coverage





# *WAAS Phased Upgrades*

- Phase I: IOC (July 2003) Completed
  - Provided LNAV/VNAV/Limited LPV Capability
- Phase II: Full LPV (FLP) (2003 – 2008) Completed
  - Improved LPV availability in CONUS and Alaska
  - Expanded WAAS coverage to Mexico and Canada
- Phase III: Full LPV-200 Performance (2009 – 2013)
  - Software enhancements, hardware upgrades
  - Steady state operations and maintenance
  - Transition to FAA performed 2nd level engineering support
  - Begin GPS L5 transition activities
- Phase IV: Dual Frequency (L1,L5) Operations (2014 – 2028)
  - Complete GPS L5 transition
  - Will significantly improve availability and continuity during severe solar activity
  - Steady state operations and maintenance
  - Will continue to support single frequency users



# *WAAS/SBAS Aviation Benefits*

- Increased runway Access
- New precision approach services
- Reduced and simplified equipment on board aircraft
- Potential elimination of some ground-based navigation aids (NDB, VOR, ILS) can provide a cost saving to air navigation service provider
- More direct en route flight paths
  - **Saves fuel, time and money**



# *GPS/WAAS Aviation Performance*

	<b>GPS Standard</b>	<b>GPS Actual</b>	<b>WAAS LPV-200 Standard</b>	<b>WAAS Actual</b>
<b>Horizontal 95%</b>	<b>36 m</b>	<b>2.74 m</b>	<b>16 m</b>	<b>1.08 m</b>
<b>Vertical 95%</b>	<b>77 m</b>	<b>*3.89 m</b>	<b>4 m</b>	<b>1.26 m</b>

*\* Use of GPS vertical not authorized for aviation without augmentation (SBAS or GBAS)*

*WAAS Performance evaluated based on a total of 1,761 million samples (or 20,389 user days)*



# *Summary*

- U.S. policy encourages worldwide use of civil GPS and augmentations
- International cooperation at all levels is a priority
- GPS continues to meet or exceed U.S. performance commitments to worldwide users
- WAAS upgrades/system improvements occurring in phases, increasing accuracy and cost savings



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